



Protecting Trees from Construction Damage

A HOMEOWNER'S GUIDE

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Contents

<i>The Root of the Matter</i>	1
<i>Plan Ahead!</i>	2
<i>Minimize the Impact of Construction Activities</i>	6
SITE CLEARING	6
SOIL DAMAGE	6
GRADE CHANGES	6
EXCAVATION	7
PAVEMENT	7
<i>Symptoms of Construction Damage</i>	9
<i>Treatment of Damaged Plants</i>	10
WATER	10
EXCAVATION OF BACK-FILLED TREES	10
AERATION	10
FERTILIZER	11
PRUNING AND WOUND REPAIR	11
OAK WILT	11
OTHER INSECT AND DISEASE PROBLEMS	11
TREE REMOVAL	12
<i>Conclusion</i>	12

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Are you planning to build or remodel a home? Before you start, consider the impact of construction on plants.

Trees and shrubs contribute to property values by enhancing appearance, reducing noise, cutting energy costs, screening unsightly views, and attracting songbirds and other wildlife. Unfortunately, plants meant to be part of a home's permanent landscape often are needlessly damaged or killed during construction. Careful planning and coordination with a tree-care specialist and your builder can reduce damage and save you the anguish and expense of treating or removing injured plants.

This publication explains some things that landowners can do to minimize the impact of construction on trees. It describes landscape protection plans, special construction techniques, symptoms of damage, and treatment strategies. Although the information presented focuses on trees, it also can be applied to protecting shrubs.

The Root of the Matter...

Trees can be damaged or killed by a wide variety of construction activities. Some practices lead to obvious injuries such as broken branches or torn bark. Open wounds of this type deplete a plant's energy resources and provide entry points for insects, or for diseases such as oak wilt.

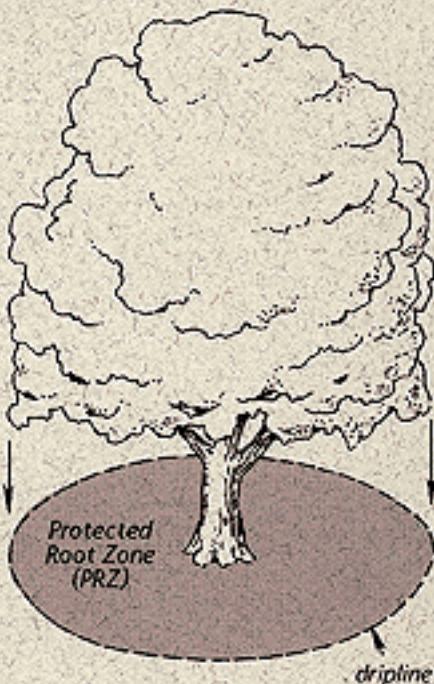


Figure 1. One common method used to define a tree's protected root zone (PRZ) is to consider it to be the part of the roots that lie directly below its branches within an area known as the *dripline*.

The worst damage, however, often remains hidden underground. Roots are one of the most vital parts of a tree. They are responsible for nutrient and water uptake, store energy, and anchor the plant. Because they are so important, it is critical that you protect roots that lie in the path of construction.

Trees are never the same shape below ground as they are above, so it is difficult to predict the length or location of their roots. However, we know that approximately 99 percent of

Hiring a Tree Care Specialist

Each construction site has its own unique set of soil, tree species, and building process conditions. For this reason we recommend that you get advice from a professional urban forester or arborist with experience in protecting trees from construction damage. This person will be familiar with the growth characteristics and common problems faced by tree species in your area. He or she can help you evaluate plant health and the likely impacts of construction activities.

For your own protection:

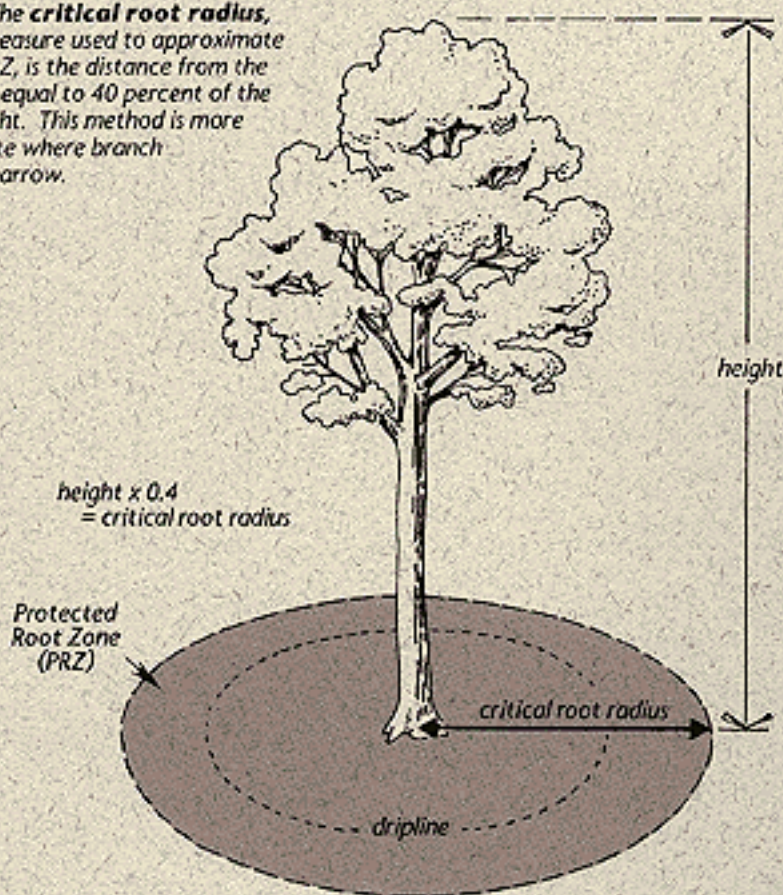
- ✓ hire only professionals who are part of an established business listed in the phone book
- ✓ ask for references
- ✓ make sure the person you hire carries insurance for property damage, personal liability, and workers compensation.

Membership in the National Arborist Association, Minnesota Society of Arboriculture, or International Society of Arboriculture or certification from the International Society of Arboriculture are good indicators of reputable businesses.

a tree's root system is in the top three feet of soil, and more than half is in the top one foot. The part of this root system in which construction damage should be avoided is called the Protected Root Zone (PRZ).

One common method used to identify the PRZ is to define it as the "dripline"—the area directly below the branches of the tree (Figure 1). However, many roots extend beyond the longest branches a distance equal to two or more times the height of the tree. For this reason you should protect as much of the area beyond the dripline as possible.

Figure 2. The **critical root radius**, another measure used to approximate a tree's PRZ, is the distance from the tree trunk equal to 40 percent of the tree's height. This method is more appropriate where branch spread is narrow.



Unfortunately, on most sites space is limited and this rule must be bent. Just how close an activity can come without seriously threatening the survival of a tree depends upon the species, the extent of damage, and the plant's health. Some healthy trees can survive after losing 50 percent of their roots. However, other species are extremely sensitive to root cutting, even outside the dripline.

Table 1 shows the relative sensitivity of various tree species to root disturbance. If possible, disturb no more than 25 percent of the roots within the dripline for any tree, protect intermediate species to the dripline, and allow extra space beyond the dripline for sensitive species. For all trees, avoid needless or excessive damage. A qualified tree-care specialist can help you determine how much root interference a particular tree can tolerate.

When dealing with trees that have been growing in the forest or that

naturally have a narrow growth habit, an approach called the "critical root radius" is more accurate than the dripline method for determining the PRZ. This is particularly true for columnar trees and for those where competition has reduced the canopy spread.

To calculate critical root radius, estimate the tree's height and multiply by 40 percent (0.40). The result is the approximate distance from the tree trunk in which a critical amount of the tree's roots may be found. Whenever possible, isolate this area from construction disturbance and treat it as the PRZ (Figure 2).



Plan Ahead!

You'll save time and money if you develop a landscape protection plan before construction begins. Careful planning will help you avoid the expense and heartache of later repairing or removing trees located too close to construction activities.

These steps will help you create a successful landscape protection plan:

1. Mark construction zone boundaries.

Obtain a complete set of site development plans, including the proposed location of buildings, driveways, sidewalks, and utility lines. Ask the builder or architect to mark areas where heavy equipment will be used, where soil will be permanently added or removed and to what depth, and where fill and building materials will be temporarily stockpiled. Use a measuring tape, stakes, and string to temporarily mark the boundaries of construction activities on the site.

2. Inventory trees on the site.

Record the location, size, and health of each tree. Wilted leaves, broken or dead limbs, trunk rot, and thin tops are all signs of stress. Trees that are overmature, display poor form, lean heavily over future buildings, or have severe insect or disease problems (Figure 3) should be marked for removal prior to construction. Also mark trees that need pruning to make room for future structures and construction equipment.

3. Select the trees to be saved.

Examine the site carefully and note how each tree fits into the future landscape. Keep in mind that the builder may be able to shift the location of a building, utility line, or

Table 1. Tree Characteristics

Species	Root Severance ⁶	Soil Compaction & Flooding ⁶	Soil pH Preference ⁸	Mature Tree Height (feet) ⁸	Mature Crown Spread (feet) ⁸	Hazard Tree Rating ⁷	Damage-Causing Roots	Landscape Value ^{**1}
Northern white cedar	Tolerant	Tolerant	6.0-8.0	40-50	10-20	Low	-	High
Balsam fir	Tolerant	Tolerant	4.0-6.0	40-60	20-35	Medium	-	Medium
White fir	Tolerant	Sensitive	4.0-6.5	50-75	10-20	Medium	-	High
Tamarack	Tolerant	Tolerant	4.0-7.5	50-75	15-25	Medium	-	High
White pine	Tolerant	Sensitive	4.5-6.5	80-100	50-80	Medium	-	High
Jack pine	Tolerant	Sensitive	4.5-6.5	30-80	20-30	High	-	Low
Red pine	Tolerant	Sensitive	4.5-6.0	50-80	20-40	(Medium)	-	Medium
Scotch pine	(Tolerant)	(Sensitive)	4.0-6.5	60-100	30-50	Medium	-	Medium
Eastern redcedar	Tolerant	Sensitive	4.7-7.8	40-50	10-20	Low	-	Low
Black spruce	Tolerant	Tolerant	3.5-7.0	30-70	15-30	(Medium)	-	Low
Colorado spruce	Intermediate	Tolerant	4.6-6.5	50-100	20-30	Medium	-	High
White spruce	Tolerant	Intermediate	4.5-7.5	40-80	20-30	Medium	-	Medium
Black ash	Tolerant	Tolerant	4.1-6.5	40-70	30-60	(Medium)	-	Medium
Green ash	Tolerant	Tolerant	6.0-7.5	30-60	30-50	Medium	-	Low
White ash	Tolerant	Intermediate	5.0-7.5	70-80	50+	(Medium)	-	Medium
Bigtooth aspen	Tolerant	Sensitive	4.8-6.3	50-75	20-35	Medium	Yes	Low
Quaking aspen	Tolerant	Sensitive	4.8-6.5	40-60	20-35	Medium	Yes	Low
Blue beech	Sensitive	Sensitive	6.5-7.5	20-30	15-20	Low	-	High
Paper birch	Intermediate	Sensitive	5.0-8.0	50-70	30-50	Medium	-	Medium
River birch	Tolerant	Tolerant	4.0-6.5	40-70	30-50	Low	-	High
Yellow birch	Intermediate	Sensitive	4.5-8.0	50-70	25-50	Medium	-	Medium
Boxelder	Tolerant	Tolerant	6.5-7.5	40-60	35-50	High	-	Low
Ohio buckeye	Intermediate	Intermediate	6.1-6.5	30-50	30-40	Medium	Yes	Medium
Butternut	Sensitive	Intermediate	6.6-8.0	40-60	50-60	(Medium)	-	Medium
Catalpa	Intermediate	Tolerant	6.1-8.0	50-80	30-50	Medium	-	Low
Black cherry	Intermediate	Sensitive	6.0-7.5	50-70	40-50	Low	-	Low
Kentucky coffeetree	Intermediate	Intermediate	6.5-7.5	50-80	40-50	Low	-	High
Eastern cottonwood	Tolerant	Tolerant	5.5-8.0	80-100	80-100	High	Yes	Low
Red-osier dogwood	Tolerant	Intermediate	6.1-8.5	8-10	10-12	(Low)	-	Medium
American elm	Tolerant	Intermediate	5.5-8.0	70-100	70-150	Medium	Yes	Low
Slippery elm	(Tolerant)	(Intermediate)	6.6-8.0	60-70	40-60	Medium	Yes	Low
Hackberry	Tolerant	Intermediate	6.6-8.0	30-130	50+	Low	-	High
Hawthorn	Intermediate	Intermediate	6.0-7.5	20-40	20-30	Low	-	High
Bitternut hickory	Intermediate	Intermediate	6.0-6.5	40-75	30+	(Medium)	-	Medium
Honeylocust	Tolerant	Intermediate	6.0-8.0	50-75	50-75	Medium	Yes	Medium
Ironwood	Sensitive	Sensitive	6.1-8.0	25-50	20-30	(Low)	-	High
Basswood	Tolerant	Sensitive	5.5-7.3	70-100	50-75	Medium	-	Medium
Black locust	Tolerant	Sensitive	4.6-8.2	30-60	20-50	High	-	Low
Red maple	Tolerant	Tolerant	4.5-7.5	50-70	40-60	Medium	-	High
Silver maple	Tolerant	Tolerant	5.5-6.5	60-90	75-100	High	Yes	Low
Sugar maple	Tolerant	Sensitive	5.5-7.3	60-80	60-80	Medium	-	High
Mountain ash	Tolerant	Intermediate	4.0-7.0	15-25	15-25	Medium	-	High
Black oak	Sensitive	Sensitive	6.0-6.5	50-80	50-70	Low	Yes	High
Bur oak	(Tolerant)	Intermediate	4.0-8.0	70-80	40-80	Low	Yes	High
Northern pin oak	Sensitive	Sensitive	5.5-7.5	50-75	30-50	Low	Yes	Medium
Red oak	Tolerant	Sensitive	4.5-7.0	60-80	40-50	Low	Yes	High
Bicolor oak	Tolerant	Tolerant	6.0-6.5	60-70	40-50	Low	Yes	High
White oak	Sensitive	Sensitive	6.5-7.5	60-100	50-90	Low	Yes	High
Wild plum	Tolerant	Sensitive	6.5-6.6	20-25	15-25	Low	-	Medium
Serviceberry	Intermediate	Sensitive	6.1-8.5	6-8	6-8	(Low)	-	High
Black walnut	Sensitive	Intermediate	6.6-8.0	70-100	60-100+	Medium	-	Medium
Black willow	Tolerant	Tolerant	6.5-8.0	30-60	20-40	High	Yes	Low

Numbers in column headings correspond to numbered sources in the reference section.

Values in parentheses reflect the authors' or technical advisors' opinions.

***Hazard Tree Rating** refers to the relative potential for a tree to become hazardous. For a tree to be considered hazardous, a potential

"target" (e.g., a house, a sidewalk, or other trees) must be present. A high hazard tree rating does not imply that the tree will always fail.

****Landscape Value** refers to the relative value of each species in Minnesota based on hardiness, form, color, growth habits, flowering and fruiting characteristics, structural strength, longevity, insect and disease resistance, maintenance requirements, and general desirability.

driveway. Although local ordinances differ, driveways and utility lines don't always have to be straight, and homes don't always have to be in the center of the lot (Figure 4). If the PRZ of a tree falls inside the construction zone, you should seriously consider changing the original design, adding protection measures, or removing the tree before construction begins.

TREE SELECTION TIPS . . .

- ✓ Save only the best; remove the rest. It is expensive for the builder to work around trees, and it also is expensive to remove damaged trees after construction has been completed.
- ✓ Understand the characteristics of your trees or get the advice of someone who does. If you know about your trees you can help insure their survival and improve the future site appearance.
- ✓ Select tree species that fit the spatial constraints of the site (Table 1), remembering that trees grow throughout their lives. Be sure to consider overhead powerlines.
- ✓ Young, small trees tend to survive disturbance better than old, large trees. Large trees almost never survive within five feet of a new building and should not be kept.
- ✓ Healthy young trees that fall in the construction zone may be saved by transplanting.
- ✓ Don't put all your eggs in one basket! Save a mixture of tree species to safeguard your landscape against contagious diseases or insects.
- ✓ Improve tree survival by saving groups of trees rather than individuals.



Figure 3. Careful planning may avoid the creation of hazardous tree situations such as damaged trees located too close to the house or dangerous overhanging limbs.

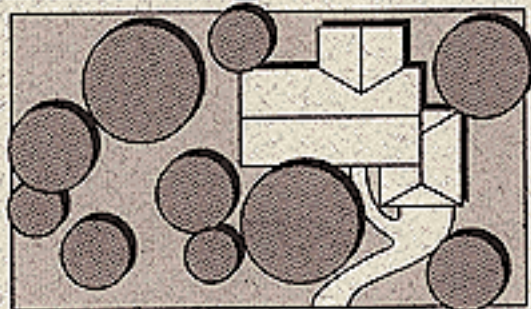
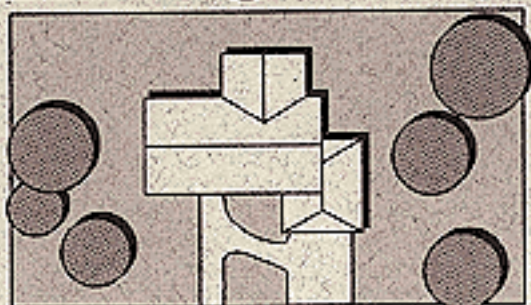
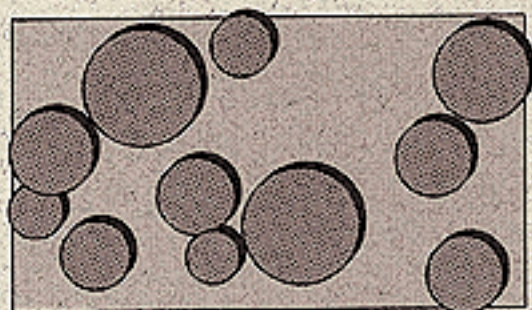


Figure 4. You may be able to save some trees by siting the new construction away from the center of the lot.

4. **Protect the trees you plan to save.**

Develop a map with the builder or architect showing the location of trees to be protected and the safest route for access to the building zone. Then install bright orange polypropylene fencing and post "Off Limits" signs at the PRZ of the trees you plan to save (Figure 5). Your primary objective is to protect delicate root systems, so provide your trees with as much space as possible. Make sure all construction workers know that nothing inside this area is to be raked, cut, stored, or otherwise disturbed. A landscape protection contract signed by the builder and all contractors will help ensure compliance. Take several photographs of the site before construction begins to document the protection methods used and the condition of individual trees.

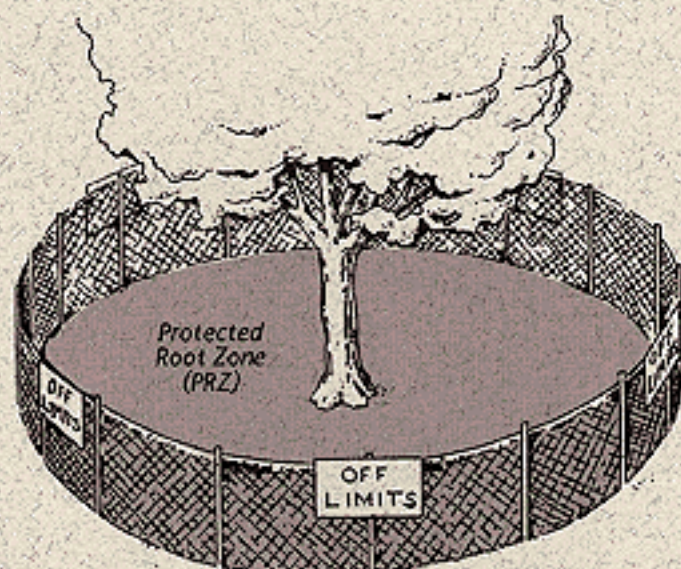
5. **Prepare the trees for construction disturbance.**

You'll boost your trees' chance for survival if you make sure they're as vigorous as possible before construction begins. Regularly water the trees if rainfall is not adequate. Fertilize them if soil tests or deficiency symptoms indicate they are nutrient stressed. (For soil test information, contact your county extension agent or call the University of Minnesota's Soil Testing Lab at 612-625-3101.) Prune branches that are dead, diseased, hazardous or detrimental to the plant's natural form.

6. **Monitor the construction process.**

Visit the site regularly and inspect the trees. Your presence alerts workers of your concern for the careful treatment of the trees. Should damage occur, begin repairs as soon as possible. Immediately inform the builder of any violations in the landscape protection contract and photograph

Figure 5. Put up fences and signs around trees you want to save to alert construction workers to damage potential.



the damage. Damage penalties should be based on the appraised value of each plant as described in *Landscape Tree Valuation* (Minnesota Extension Service publication NR-FO-7026). Insist that protective fences remain in place until all construction workers have left the site.

7. **Make a final inspection of the site.**

After construction has been completed, evaluate the condition of the remaining trees. Look for signs of damage or stress. It may take several years for severe problems to appear. Careful monitoring and preventive treatment (e.g., watering) may help minimize damage.

Minimize the Impact of Construction Activities

In addition to protecting the PRZ, there are other ways in which you can reduce the impact of construction activities on your trees. Some of these are relatively simple; others can be extremely expensive. Carefully consider the importance of each tree to the future appearance of the site and consult a tree-care specialist before deciding whether protective measures are worth the cost.

SITE CLEARING

When you remove a large number of trees, you expose the remaining plants to new conditions. Sudden increases in amounts of sunlight and wind will shock many of your trees. It is not uncommon to find scorched leaves, broken branches, and uprooted trees after a site is cleared. Although some of these problems are temporary, they may compromise tree health when coupled with additional construction damage.

You can avoid sun and wind stress by saving groups of trees rather

than individuals. When possible, remove the unwanted plants in winter after the leaves have fallen. Dormant plants are less susceptible to damage, and frozen ground helps protect roots. Bulldozers should not be used to remove trees near plants to be preserved. Heavily wooded sites should be gradually thinned over two to three years to reduce removal shock on remaining plants. This is especially important in dense pine, spruce, or fir forests.

SOIL DAMAGE

Soil compaction is the single largest killer of urban trees. Tree roots need loose soil to grow, obtain oxygen, and absorb water and nutrients. Stockpiled building materials, heavy machinery, and excessive foot traffic all damage soil structure. Lacking good soil aeration, roots suffocate and tree health declines.

Prevent soil compaction by carefully selecting storage areas and traffic routes (the future driveway is a good choice for both) and installing protective fences and signs. If you can't reroute traffic, install root system bridges (Figure 6) or spread several inches of wood chips on the soil within the PRZ. Heavy mixing trucks can be kept off tree roots by transport-

ing concrete from the truck through conveyor pipes.

Improper handling or disposal of materials used during construction also can harm roots. For example, wood products treated with pentachlorophenol and creosote can be deadly to tree roots; CCA-treated timber (greenish color) is a better alternative. Ask the builder about the materials to be used on the site and read product labels. Chemical spill damage can be prevented by filling gas tanks, cleaning paintbrushes and tools, and repairing mechanical equipment well outside tree PRZs. Insist that all building debris and chemical wastes be hauled away for proper disposal, and not burned or buried on the site.

Finally, avoid changes in soil pH (acidity). Increases in pH are particularly dangerous to many species (Table 1). Alkaline clays or limestones should not be used for fill or paving, and concrete should be mixed on a thick plastic tarp or outside the site. Mixing trucks should never be rinsed out on the site.

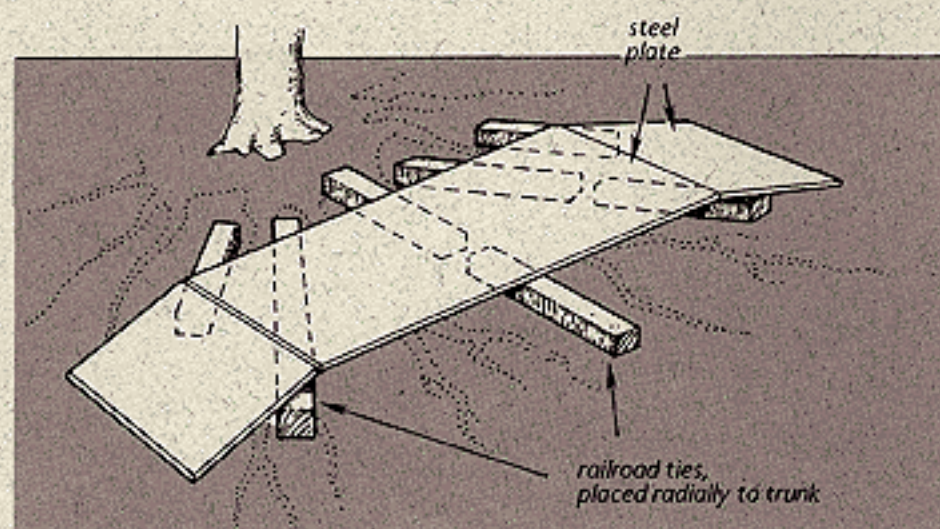
GRADE CHANGES

Moving large amounts of soil within the PRZ usually kills a tree. Except where absolutely necessary, avoid disruptions to the natural contour of the site or shift them well outside the PRZ.

Soil additions compact the soil around a tree and often raise the water table. You may be able to protect compaction-tolerant trees (Table 1) from additions of six inches or less of soil by using a porous fill within the PRZ. Porous fill can be made by mixing one part loam, one part coarse sand, and one part shredded bark.

Deeper fills require more expensive measures. A retaining wall beyond the PRZ may protect some trees (Figure 7a). These walls preserve much of the original root system and redirect excess water away from sensitive plants. Your tree-care specialist may suggest other, more elaborate measures for protecting trees

Figure 6. A root system bridge will help protect trees in the path of construction vehicles.



that must be covered with soil close to the trunk. However, as a general rule it is best to remove trees that would be buried by 24 inches or more of fill around the base.

Cutting the soil away from a tree removes vital feeder roots, eliminates nutrient-rich topsoil, and often lowers the water table. Damage caused by shallow cuts (less than two inches) at least three feet away from the base of the tree may be minimal, but still can be a shock to a tree's vigor. If possible, avoid making the cut during hot, dry weather; water the tree (undisturbed portions) before and after soil removal; and allow only hand digging inside the PRZ. A shallow layer of mulch (pine needles, wood chips, or coarsely chopped twigs and bark) and clean root cuts will help wound closure and regrowth. Deeper cuts within the root zone will require

construction of a retaining wall no closer than the limit of the PRZ (Figure 7b).

EXCAVATION

As much as 40 percent of a tree's root system could be cut during the installation of a nearby utility line. This reduces water and nutrient uptake, and may compromise the stability of the tree. If it is not possible to relocate the utility line outside the tree's PRZ, you can reduce root damage by as much as 25 percent by tunneling under the tree's root system (Figure 8). When digging a trench near a tree, begin tunneling when you encounter roots larger than one inch in diameter.

Trenching for building foundations also poses a danger to nearby trees. Although not often used in

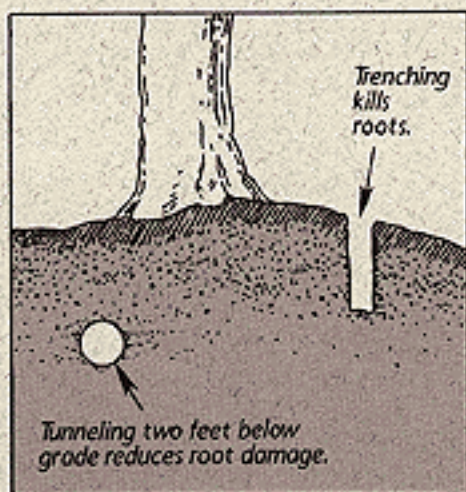


Figure 8. Protect roots from damage when laying utility lines by tunneling rather than trenching.

Minnesota, posts, pilings or I-beams sometimes can be substituted for foundation walls and footers on homes (Figure 9). Drilling single holes as opposed to cutting deep trenches saves many critical roots.

For all digging operations, insist that exposed roots be cut cleanly to promote quick wound closure and regeneration. Vibratory plows, chain trenchers, and hand tools do a better job at this than bulldozers and back-

Figure 7. If you change the grade within the root zone, use retaining wall to keep as much of the original grade as possible. **a)** backfilling; **b)** cutting.

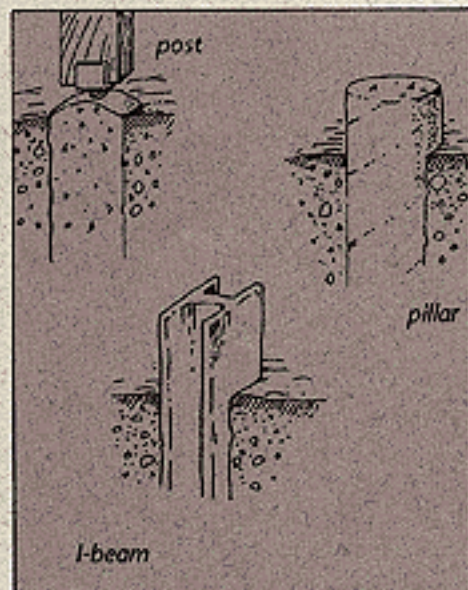
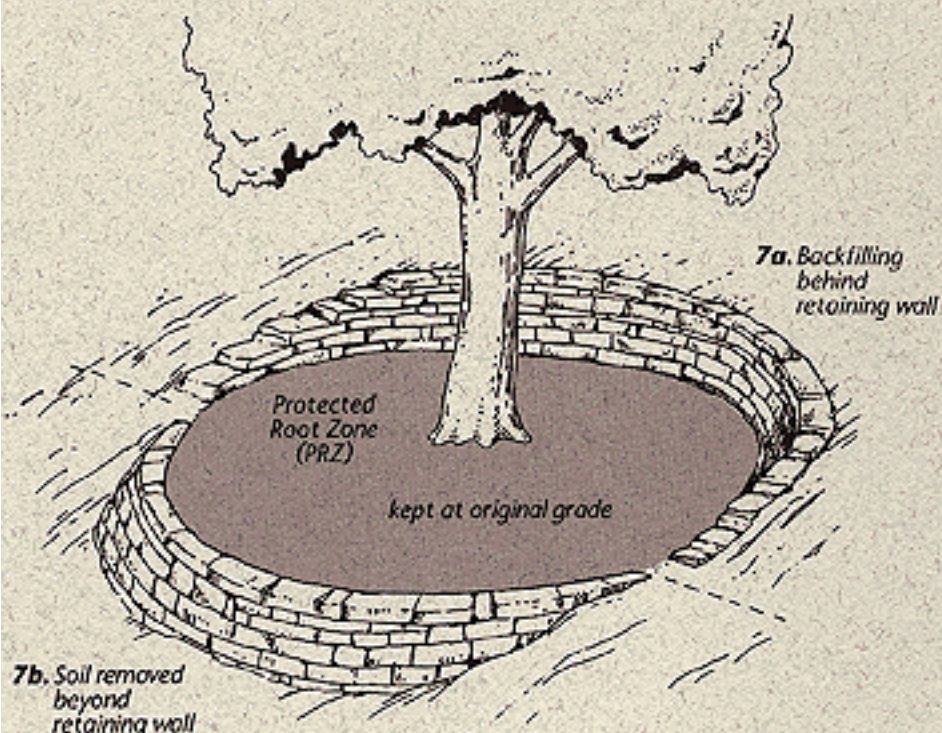


Figure 9. You can minimize damage to trees near foundations by using posts, pillars, or I-beams rather than foundation walls.

hoes. Minimize damage by avoiding excavation during hot, dry weather; keeping the plants well watered before and after digging; and covering exposed roots with soil, mulch, or damp burlap as soon as possible.

PAVEMENT

Sidewalks and driveways located too close to a tree endanger its health and may threaten pavement stability. Factors such as frost heaving, poor drainage, and pavement flaws give roots an opportunity to expand, gain a foothold, and cause damage. Homeowners are faced with costly repair bills and potential liability for the hazardous situation that develops.

These problems can be avoided if you consider the spatial needs of a tree and its root system when designing the layout of new sidewalks and driveways. Just how much space is required depends upon a tree's sensitivity to root cutting and its future size (Table 1). It's best to locate sidewalks and driveways outside the anticipated PRZ. At a minimum, walkways should be at least three feet from the trunk of a tree; driveways may cover up to half the distance from the tree's PRZ to its trunk, as long as no excavation occurs. No tree should be boxed into an area less than eight feet by eight feet by three feet, with larger trees receiving at least 300 cubic feet of root/soil volume.

You can minimize disruption by using alternatives to conventional paving materials. In some communities, brick or flagstone walkways on sand foundations can be substituted for concrete (Figure 10). These materials protect soil pH and allow water and oxygen penetration. Preserve natural contouring by spanning uneven areas with wooden walkways elevated on posts. Elevated decks are excellent alternatives to concrete porches. Where additional pavement strength is needed (e.g., driveways), concrete requires less excavation than asphalt. Ask your builder about raised pavement techniques near valuable trees.

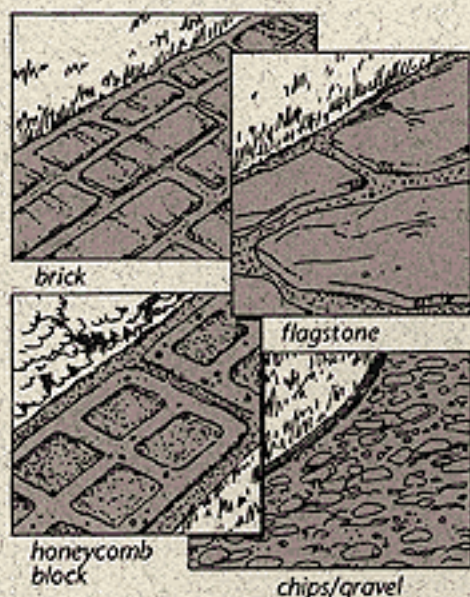


Figure 10. Paving materials such as brick or flagstone over sand will produce less disruption than poured concrete to the roots of a nearby tree.

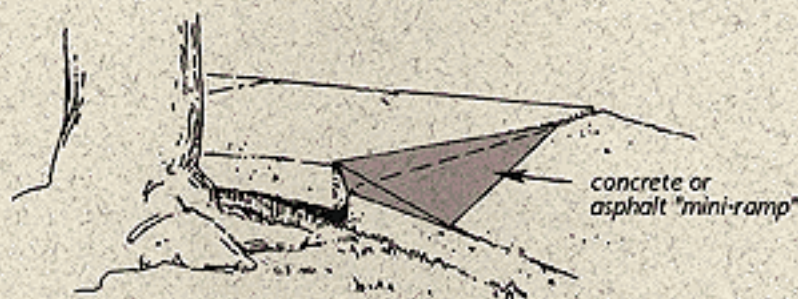


Figure 11. A "mini-ramp" can be used to smooth the uneven surface caused by root damage to pavement.

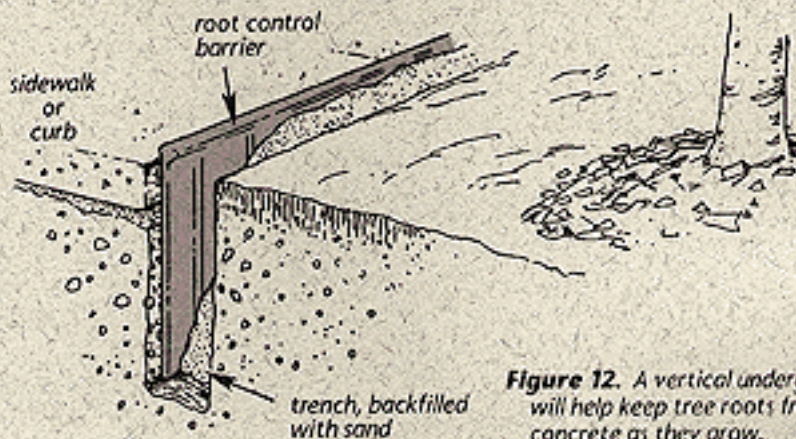


Figure 12. A vertical underground barrier will help keep tree roots from damaging concrete as they grow.

There are several techniques for repairing pavement that has been damaged by protruding roots. For trees that are highly sensitive to root disturbance, consider creating a concrete or asphalt "mini-ramp" to smooth the uneven surface between two sidewalk sections (Figure 11). Local ordinances governing liability should be consulted prior to using this technique. Relocate walkways with broken concrete slabs a few feet farther from the tree. For trees that can tolerate root disturbance, a vertical underground barrier may redirect root expansion away from pavement (Figure 12).

All tree species are capable of causing root damage to sidewalks, foundations, or pipes. Species notorious for damage-causing roots are noted in Table 1.

Symptoms of Construction Damage

Conspicuous symptoms of construction damage may take years to appear. Tree decline from soil compaction, for instance, may take three to seven years to appear as obvious symptoms of distress. Because of this delay, landowners often attribute tree losses to other causes. Carefully monitor affected plants and keep written records to help you recognize the less visible signs of tree stress. Remember, the most serious damage remains hidden in the root system.

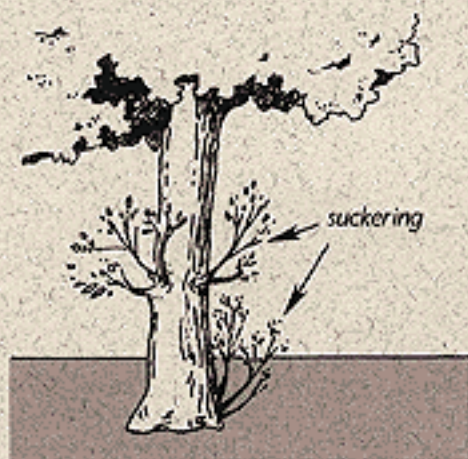


Figure 13. Suckering is one symptom of construction damage.

Wilted or scorched leaves and drooping branches usually are the first signs of construction damage. In deciduous plants these symptoms may be followed by early fall coloring and premature leaf drop. Damaged conifers will drop excessive amounts of inner needles. In subsequent years you may notice yellowed or dwarfed leaves, sparse leaf cover, or dead branches.

Other indicators might include flowering out of season, excessive sucker formation on the trunk (Figure 13), or abnormally large amounts of seed. These responses are defense mechanisms for ensuring species

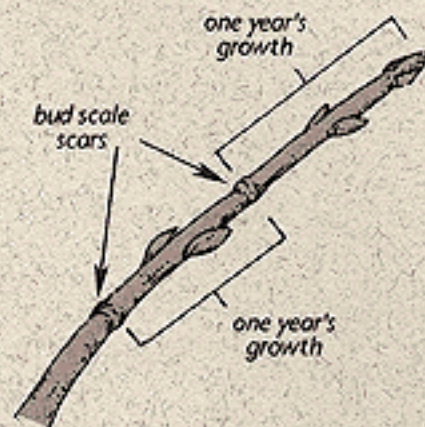


Figure 14. Annual growth is the distance between bud scale scars on twigs. The twigs of healthy trees usually grow two to six inches longer each year.

survival and commonly indicate that the plant is experiencing extreme stress.

In addition to observing a tree's appearance, monitor its annual growth. A slightly damaged plant will grow more slowly and be less resistant to insects, diseases, and

weather-related stress. Examine the annual shoot and branch growth (Figure 14). Healthy trees generally will grow at least two to six inches at the ends of the branches each year. Photographs and records of the tree prior to construction also can help identify growth problems.

If you purchased your home following construction, you can identify deep fills around large trees by looking for buttress flares at the base of the trunk (Figure 15). Most common shade trees in Minnesota have buttress flares, and their absence usually indicates that the tree's base has been covered. It may be helpful to examine the condition of trees on other sites where your builder has worked.

In many cases you would be wise to have a tree-care specialist look for early symptoms of tree stress. Dollars invested in consultations with professionals before damage becomes obvious may be repaid in considerable savings later on.

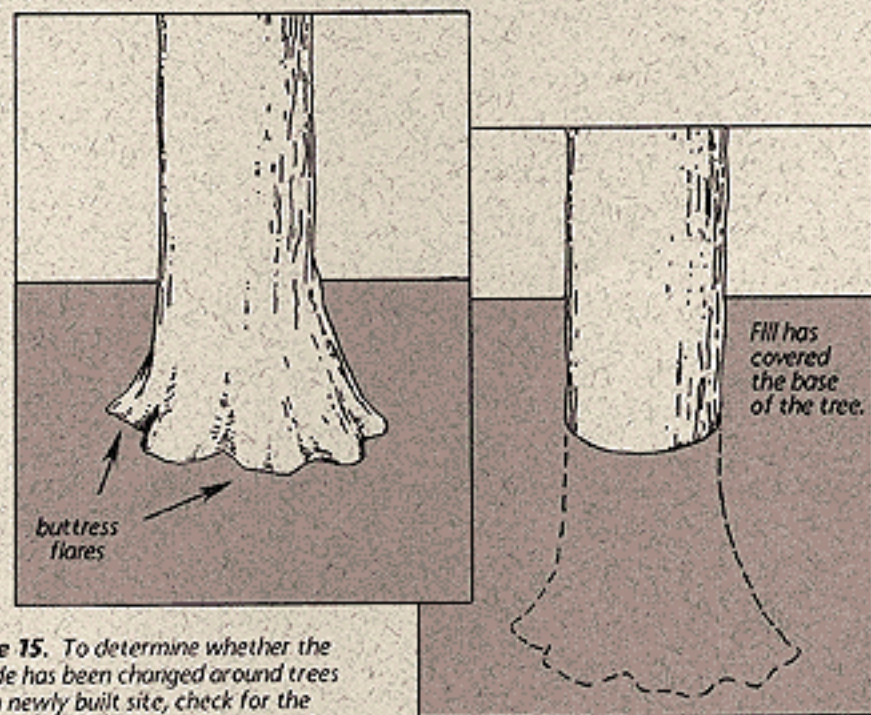


Figure 15. To determine whether the grade has been changed around trees on a newly built site, check for the presence of **buttress flares** at the base of the trunk.

Treatment of Damaged Plants

When a tree is injured by construction activities, energy and resources normally used for growth must be redirected towards the process of wound closure and regrowth. During this critical period plants are particularly vulnerable to additional stress, especially insects, diseases, and severe weather. You can minimize these problems by quickly treating the damage.

WATER

Construction activities often alter the amounts of water received by trees. Thoroughly water plants before and immediately after they receive any kind of direct damage (e.g., severed roots). Continue periodic watering (four to five times per summer) throughout the next growing season. Be careful not to overwater your trees. A one-inch depth of water applied throughout the PRZ is a good rule of thumb. A tin can or glass jar can be used to measure the amount of water applied if an overhead irrigation system is used. Concentrate most of the water on undamaged sections of the root system.

Two to three inches of mulch (wood chips or bark) spread over as much of the root system as practical will help the tree retain water and stimulate root regeneration. Living ground covers over the root system will have a similar effect, and may be more aesthetic. Apply these techniques to any deciduous tree exhibiting wilted leaves or any coniferous tree dropping excessive amounts of needles from the inner branches.

Drainage systems and grade changes may cause some trees to receive too much water. Species differ in the amount of water they can tolerate (Table 1). Intolerant plants will exhibit twig and branch death. Don't wait for these symptoms to appear. If you suspect your plant is

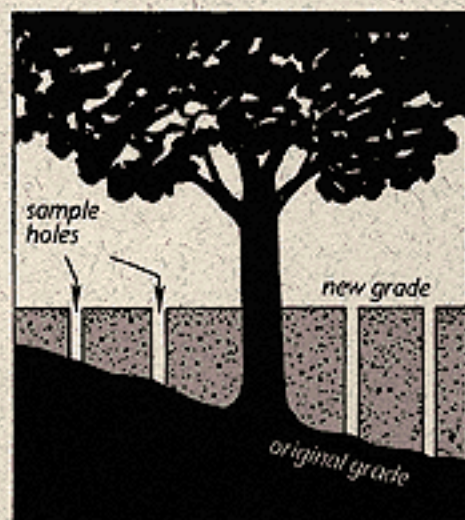


Figure 16. Before you remove fill that has been added around trees, take vertical samples to determine how deep you need to go.

receiving too much water, contact a tree-care specialist for an evaluation of the problem. Treatment differs by tree species and by the amount of time the water remains on or close to the surface. For some species, a retaining wall or culvert may be needed to redirect the flow of water.

EXCAVATION OF BACK-FILLED TREES

If you or your tree-care specialist has determined that excessive soil additions have been made around valuable trees, efforts should be made

to restore the original grade, at least within the PRZ.

Approach this grade restoration carefully. Determine how much fill has been added by sampling depths at several different points within the PRZ (Figure 16). If the depth is great (more than 12 inches), you may remove most of the backfill with mechanical equipment. Once you are within 10 to 12 inches of the original grade, complete the fill excavation carefully with shovels and rakes. Make certain no soil is piled up against the tree trunk, and aerify the soil within the PRZ to complete the operation. If the tree is already exhibiting advanced symptoms of decline, however, restoration to original grade will probably be fruitless. In this case, remove the tree and plant a new one.

AERATION

Soil compaction around a tree's roots may cause leaf wilt, early fall coloring, top dieback, and slow growth. Reduce compaction by carefully drilling a series of two-inch diameter holes in the soil to a depth of twelve to eighteen inches. Begin three feet from the tree trunk and continue drilling at two-foot intervals in concentric rings around the tree out to the PRZ (Figure 17). Each hole may be refilled with sand, peat moss, or

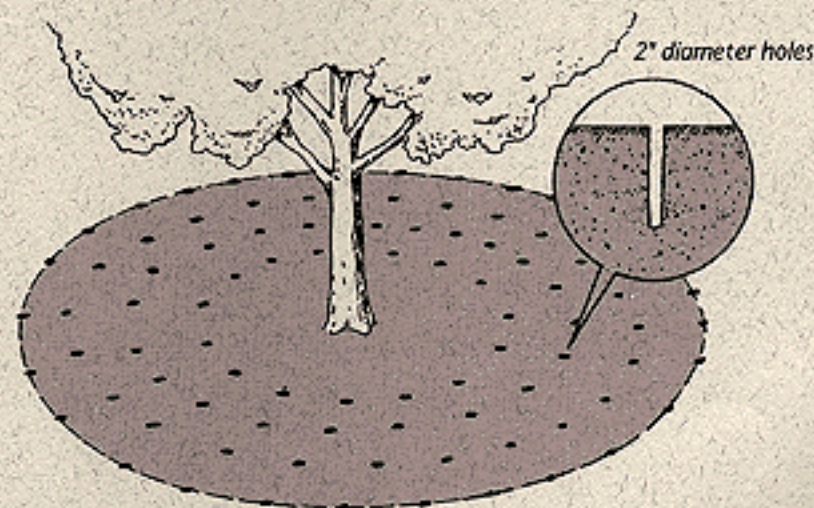


Figure 17. A series of two-inch holes 12 to 18 inches deep will help alleviate root damage caused by compaction.

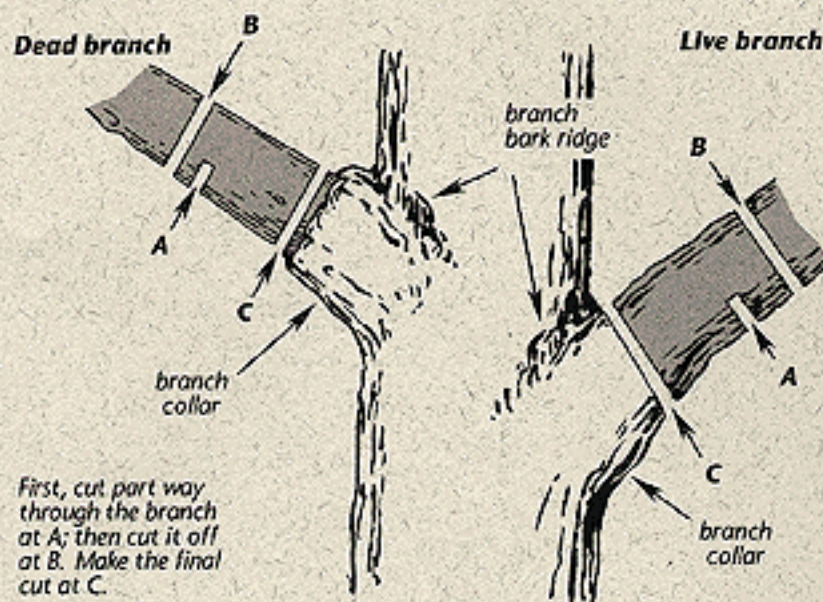


Figure 18. Prune branches at the branch collar.

mulch. A tree-care specialist may recommend other alternatives, including soil injections of air or pressurized water, to improve soil aeration.

FERTILIZER

Injured trees may need additional nutrients to replace damaged root systems. Fertilizers containing phosphorous and nitrogen can help stressed plants recover since these nutrients promote root and plant growth. Avoid excessive nitrogen; increased stem and foliage growth can cause stress, especially during hot, dry weather or if the tree has been stressed due to construction activities. Because of this problem, many experts recommend waiting two years after damage has occurred before fertilizing the trees. Specific guidelines for selecting and applying fertilizer are described in *Tree Fertilization* (Minnesota Extension Service publication AG-FO-2421).

PRUNING AND WOUND REPAIR

Careful pruning and wound repair are important treatments for damaged trees. Prune broken or dead branches cleanly at the branch collar

(Figure 18). To test whether a branch is dead, bend several twigs. Twigs on live branches tend to be pliable, while twigs on dead branches tend to break. Buds also can be used to evaluate branch condition. Live buds appear full and normal in color while dead ones appear shriveled or dry.

Pruning is commonly recommended for large trees that have suffered root damage. Opinions differ over the merits of this practice. Assuming that the tree has adequate water and is not in severe decline, some experts believe that retaining maximum leaf cover is important for root regeneration and only dead limbs should be removed. Others argue that pruning selected live limbs is necessary to compensate for lost roots. Generally, it is best to follow the recommendation of your tree-care specialist.

When properly done in moderation by a skilled professional, pruning may reduce wind resistance and limb failure and improve tree health and appearance. Except in extreme cases (e.g., overhead powerlines), DO NOT let anyone cut off all of the top branches to the same height ("topping").

The treatment of trunk wounds depends on the extent of damage. If the bark has been completely removed around the entire trunk, the tree will not survive and should be removed. If only a patch of bark has been removed leaving a few splinters, use a sharp knife to cleanly cut off the loose bark to a place on the stem where it is firmly attached. DO NOT make the wound any larger than necessary.

You do not need to use pruning paint or dressing to cover exposed wounds or pruned limbs. Except for special cases involving disease control, these products do little more than improve appearance.

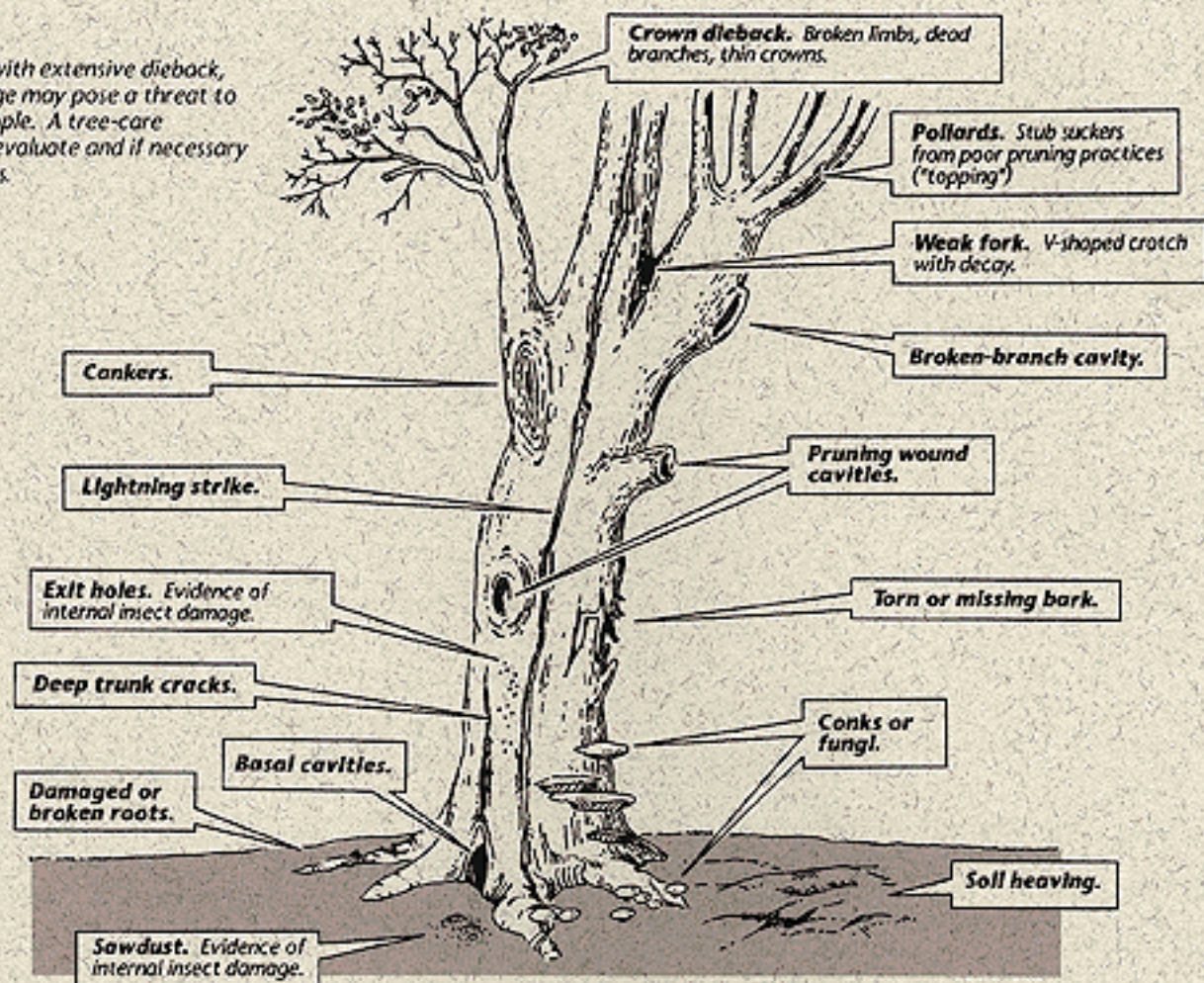
OAK WILT

Oak wilt is a lethal fungal disease normally spread through root grafts between adjoining oak trees. The disease also may be spread overland by picnic beetles. In Minnesota, construction activities that injure roots, break branches, or otherwise open a wound on an oak between May 1 and July 1 provide the beetles easy access to transmit the fungus. (Some studies have found the occurrence of oak wilt to be four times more likely within 160 feet of a construction site.) Immediately cover all open wounds with any latex paint during this period. If you suspect oak wilt, contact your city forester or private tree-care specialist. If you have oaks on your site, obtain a copy of *Oak Wilt in Minnesota* (Minnesota Extension Service publication NR-MI-3174) for additional information on identifying the disease and protecting your trees.

OTHER INSECT AND DISEASE PROBLEMS

Insects are attracted by distinctive chemicals that are released by plants recovering from injuries. Examples of insect pests that can sense a tree under stress include the pine bark beetle, bronze birch borer, two-lined chestnut borer, picnic beetle (transports oak wilt fungus) and some scale insects. These insects can kill a plant by their feeding or boring or by transmitting disease.

Figure 19. Trees with extensive dieback, disease, or damage may pose a threat to property and people. A tree-care specialist should evaluate and if necessary remove such trees.



Likewise, some diseases multiply in plants experiencing stress. Verticillium wilt, ash yellows, and Armillaria mellea are examples of diseases that attack weakened trees.

Continually monitor the health of your trees, especially those near construction activities, for insect and disease problems. Proper treatment, including corrective pruning, watering, and pesticide or fungicide applications, can restore tree health. Contact your county extension agent or local forester for additional information on specific tree pests.

TREE REMOVAL

Even the best protection plans cannot guarantee plant survival. Death may occur shortly after construction or years later. Look for trees with very few leaves and many dead branches. If the tree does not leaf out the following year it is dead. Large trees that lean or exhibit rot, deep

trunk cracks, or extensive top dieback are potentially hazardous (Figure 19). They should be evaluated by a tree-care specialist or be removed. Dead trees are excellent for wildlife, but dangerous to people and buildings. Large trees should be carefully removed by professionals so as not to damage the remaining plants.

Tree loss can have a dramatic impact on site appearance. Prompt replacement will minimize your grief. Remember, the tree you plant is your own.



Conclusion

It's not always easy to save trees during construction, but your efforts are worth the trouble. Healthy, well-placed trees can increase property values by 9 to 27 percent. Protecting tree health on a construction site is a matter of recognizing the potential impacts. Advance planning and simple steps to minimize damage often can prevent future problems. Many trees have a tremendous capacity to survive disturbance, but in an urban setting we continually test them. Take the time to protect and monitor the health of your investment. Your home and our communities will be healthier, more attractive places to live.



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